Educational_game_RPG_for_mathematical_understanding_ability.pdf

by

Submission date: 06-Aug-2021 07:23AM (UTC+0700)
Submission ID: 1628210086
File name: Educational_game_RPG_for_mathematical_understanding_ability.pdf (1.28M)
Word count: 8839
Character count: 46461

International Journal of Education and Learning
Vol. 3, No. 2, August 2021, pp. 76-93

ISSN 2684-9240

The incredible boong gi: Educational game RPG for mathematical understanding ability

Setiyani [a,1], Sri Sumarwati [b,2], Laela Sagita [c,3,*] Dzaki Fadhlurrohman [a,4]

[a] Department of Mathematics Education, Universitas Swadaya Gunung Jati, Cirebon, Indonesia
[b] Technical and Vocational Education, University Tun Hussein Onn Malaysia, Johor 86400, Malaysia
[c] Department of Mathematics Education, Universitas PGRI Yogyakarta, Indonesia
[1] setiyani@fkip-unswagati.ac.id; [2] sri_fathoni78@yahoo.com; [3] laelasagita@upy.ac.id*; [3] dzaki_math@gmail.com

* corresponding author

ARTICLE INFO

Received
Revised
Accepted
Published

Keywords
Role playing game
Interactive learning
ADDIE model
Mathematical understanding ability

ABSTRACT

Some of the android-based mobile game genres that are currently very popular such as adventure, first-person shooter, fighting, racing, and others. This development should provide opportunities in the field of education to make games not only for fun but also for education. The purpose of this study was to produce educational games that were valid, practical, and had potential effects to improve the mathematical understanding of the relationship and function of junior high school students. The research method used is R&D (research & development) using the ADDIE model. The data collection techniques used were documentation, interviews, and tests of mathematical comprehension abilities. The results obtained from the game "The Incredible Boong Gi" are valid with an average of 96.70% of expert validators and media validators. The results of the practicality questionnaire from 9 students averaged 90.32%. The results of data analysis show that educational RPG games have valid, practical criteria and have potential effects. RPG games are valid in terms of relevance, systematics, student-centered compatibility, game design, and compatibility. RPG games get practical results from implementation in small groups. Furthermore, the educational RPG prototype has the potential effect of improving students' mathematical understanding abilities. RPG games provide a fun learning atmosphere, by playing students can also learn. Making RPG games is also not difficult, according to the competence of students to be achieved and challenges the creativity of the teacher.

This is an open access article under the CC–BY-SA license.

1. Introduction

Mathematics is a science that is not just counting. In mathematics, we learn to develop scientific situations, draw conclusions, and solve problems [1]. Before solving a problem, students must understand the material being taught. This is in line with the National Council of Teachers of Mathematics (NCTM) that the standard principles of mathematics in learning mathematics at school are to develop and deepen understanding of mathematical concepts and relationships as they create, compare, and use various representations [2]. The ability to understand mathematics is very important for students to master because it is an ability that underlies the development of other abilities, such as problem solving, critical thinking, etc [3]. For this reason, several mathematical abilities must be mastered in learning mathematics, one of them is understanding concepts. Some indicators of the ability to understand concepts that must be possessed by National Education Departement are (1) repetition of concepts; (2) classifying particular objects according to concepts; (3) give examples and not examples of concepts; (4) presents concepts in various forms of mathematical representation; (5)

developing the necessary or sufficient conditions of a concept; (6) use and use and choose specific procedures or operations; (7) applying concepts or algorithms in problem solving [4].

In line with that, solving problems related to relationships & functions is one of the learning objectives of students. However, based on research in the field it is mentioned that the mathematics understanding of grade VIII students about the relationship and function of the material is still lacking. Based on the results of preliminary experiments in class VIII which showed only 47.3% of students answered correctly from 30 students. Those students are still unable to present concepts in various representations and difficulties in using concepts / algorithms in problem solving. The obstacles can be seen from one of the results of students' answers to the following relation and function material.

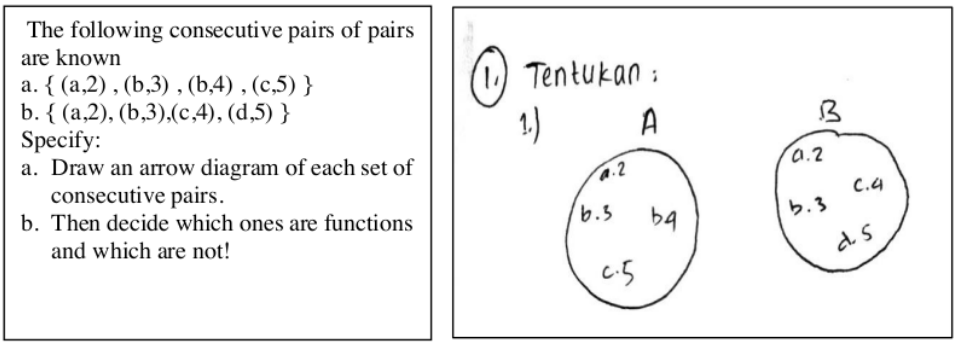


Fig. 1. Preliminary analysis

Based on Fig 1, most students still have difficulty working on relation and function problems. Therefore, it is necessary to have innovation in learning so that students easily understand the material, one of which is learning media. Learning media is an important thing that must be considered to achieve learning goals because it is a tool to convey material that can stimulate students' attention, interests, motivation, thoughts, and feelings in student teaching and learning activities [5]. Also, the use of media increases students' understanding of mathematical concepts, so that mathematics learning achievement in relationships and functions increases [6]. Therefore, the creativity and innovation ability of teachers in making instructional media is needed. Game-based learning media has many advantages [7] including involving students in learning activities and helping to learn naturally [8]. Based on the results of Raharju and Hartono's research, Indonesian monopoly game-based mathematics learning improves mastery learning mathematics in each cycle [7]. Then, the research conducted by Rahmawati, Buchori, and Bhihikmah show that the Sundanese Manda game is effective in junior high school mathematics learning [9]. Mobile Learning Game learning media based on the contextual approach is effective in understanding students' mathematical concepts [10]. From some of the research results it can be concluded that game-based learning is better than traditional learning.

The rapid development of technology builds technology used as a medium of learning. The application of educational technology media in teaching and learning helps teachers communicate information that is of interest to students. The use of technology-based media has a very significant effect. According to Suprianto, et al., mobile learning is one of the digital technologies that have the potential to be developed in teaching and learning and learning [11]. Mobile learning (m-learning) is defined as learning that occurs when students have an access to information anytime and anywhere through cellular technology learning [12]. Therefore, learning becomes flexible because it's not limited by time and place. The smartphone is one of several types of m-learning devices used as digital-based devices [6]. Based on a study by Zhang, Trussell, Gallegos, & Asam, mathematical applications from mobile devices used as learning media that can improve student achievement [8]. Smartphones in Indonesia are projected to increase from 2016 to 2019. Indonesia is in the first position of smartphone user data in Southeast Asia [13], so that smartphone devices can be used as appropriate devices for m-learning. Each smartphone has a different operating system such as iOS, Android, Windows Phone, etc. Especially in Indonesia, Android is the most widely used smartphone. This was obtained from the International Data Corporation (IDC), which stated that the top 5 smartphone vendors in the third quarter of 2019 from smartphone vendors operating on Android systems such as

International Journal of Education and Learning
Vol. 3, No. 2, August 2021, pp. 76-93 ISSN 2684-9240

Samsung, OPPO, Vivo, Xiaomi, and Realme. Also, Android is an open-source Linux-based operating system [8]. This is the reason why Android was chosen as a suitable mobile device for m-learning.

Whereas games are now very popular applications on Android [14]. Some mobile game genres that are now very popular such as adventure, shooting, competition, racing, and others, are just fun and not educational. That way, educational games are felt to be needed as a learning media, especially to achieve learning goals. Educational games are games that have an educational element in them [15]. The educational game was chosen as a cellular learning media deemed appropriate for use on Android devices because Android is opensource, making it possible to create software & applications, especially educational games. Learning like this is relatively new among educators, and the use of educational games has an effect on student motivation [16]. In addition, the implementation of educational games as a learning medium provides a more pleasant atmosphere than traditional classes [17]. The hope is that Game-based learning can attract students' interest in learning, especially learning mathematics [18]. The type of educational game used in this study is the RPG (Role Playing Game) genre. RPG is one of the most popular games [19] and more flexible compared to other genres [20]. Educational games as a fun learning tool have the potential to provide new learning opportunities for students [21]. In contrast with Belloti et al, Agusdinata and Lukosh stated that RPG is a game with a serious genre to facilitate students' understanding of complex problems [22]. Thus, it is hoped that this Android-based RPG educational game can meet the needs of students in learning to achieve learning goals with fun. In making a design and development of learning tools, we need a methodology and model that is arranged systematically and programmed to achieve the design objectives.

The selection of this model is based on the consideration that this model is developed systematically and rests on a theoretical foundation [23]. ADDIE is one of the systematic learning design models. is expected to be a model that provides solutions to students' learning problems. The stages of activities contained in the ADDIE model consist of 5 stages, as in Fig 2.

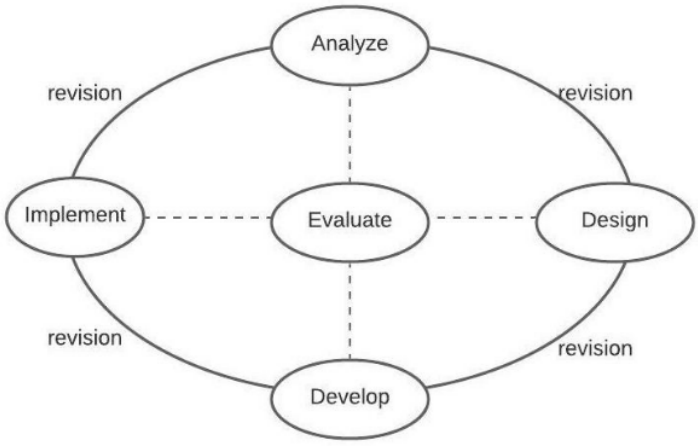


Fig. 2. ADDIE Model

The media used in this study is the RPG Educational Game, which is a digital game created with the aim of providing education or learning to students. RPG itself is an abbreviation of the Role-Playing Game which is a classic genre where students will play the role of the cast or the main character. The main character is demanded to follow each game story line from the beginning to the end of the game. The selection of RPG games as a medium in this study is not without reason. games are considered to attract the attention of student learning. This is in line with the statement of Pramuditya et al, that students who are curious to know the storyline of the RPG game at the same time will make students gain knowledge as well when completing RPG style games [24]. The use of educational game media is also rated better, this is in line with what Hung, Huang, and Hwang, the achievements of students who learn to use games on mobile devices are higher than students who use e-book applications in learning [25]. The use of educational games can increase learning independence and students' perceptions of subject matter [26].

Game-based learning with a narrative about the legendary Malaysian warrior, Merong Mahawangsa has also been developed in Malaysia for history [18]. Furthermore, the development of the game "Tales of Momochi" using an Android-based RPG with characters who can cook, fight monsters, farm, collect books, make crafts, etc. is developed with the aim of entertaining the user [27]. Chen and Ren did an RPG game development for the primary number concept for elementary school [28]. The results showed that the implementation of the RPG game motivates students and increases the knowledge of low category students. Pramuditya, et al. have also developed RPG games on relation and function materials [29], but they do not focus on certain mathematical abilities. Apart from mathematics, RPGs can also be used in various disciplines. For example, the results of Rahman and Anggraeni's research, which state that RPG games develop students' skills in mastering vocabulary words [30]. In contrast to previous studies, the RPG games in this study were developed with an interesting storyline and focused on the ability to understand mathematical relations and functions for junior high school. Therefore, the aim of this study is to design an Android-based RPG educational game for valid and practical mathematical understanding of material relations and functions. Android-based learning media in the form of games contribute to education in training the skills of 21st century students [31].

2. Method

This research is a type of R&D (Research Development) using the ADDIE model. According to Branch [24], the ADDIE method has five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

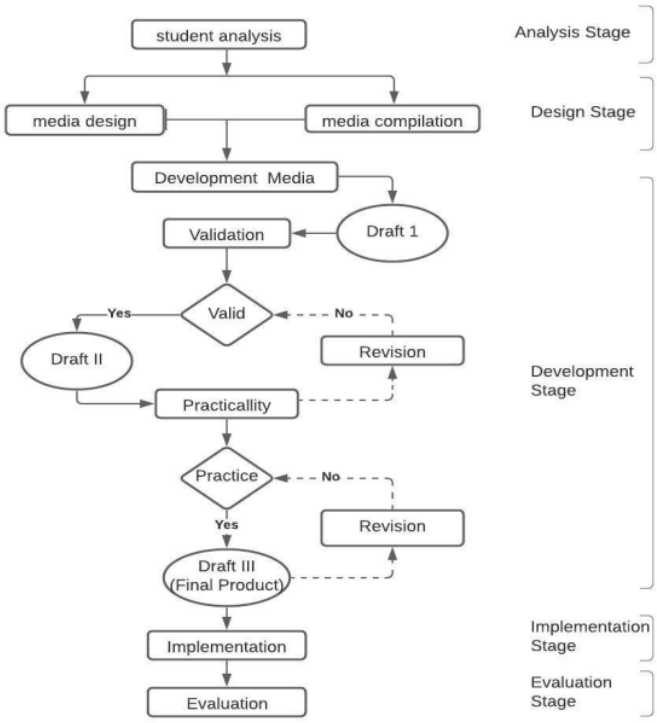


Fig. 3. Research Flow

This game material is about relationships and functions. In the first stage (analysis), the authors analyze the results of interviews with students and teachers to find problems while looking at students' needs.Then in the second stage, namely design. In this step, the writer makes game concepts such as main characters, storylines, maps, materials, and questions that will be used as needed at the analysis

International Journal of Education and Learning
Vol. 3, No. 2, August 2021, pp. 76-93
ISSN 2684-9240

stage. The last step is the development stage. At this stage of development, the author makes the game into the APK format and then gets validation from validator. Next is the implementation stage to see the practicality of users and students' learning completeness. The implementation stage is carried out at Lemah Abang Junior High School. The subjects of the study were nine respondents, namely three students with high abilities, three students with moderate skills, and three students with low skills. Taking the research subject is sufficient to provide information in this study.

Table 1. Validation

Aspect	Indicators
Relevance	Material is relevant to the competencies that must be mastered by students.
	The task is relevant to the competencies that must be mastered.
	Exercises and questions in the game are relevant to the material that presented and relevant to mathematical understanding skills that must be mastered by students.
Systematics	The plot of material in the game follows the plot of thought from simple to complex.
	The material presented coherently.
	The contents of learning material are easy to understand.
	Using words that is clear and easy to understand
The compatibility of the course with the demands of student-centered learning.	Encourage students curiosity
	Fostering student interaction with the game presented
Game Design	Each map has interesting display.
	Movement between maps is clear (not confusing).
	Interesting Characters in games.
	The text in the game is clear and legible.
	The picture and audio in the game is clear.
	The plot or scenario in the game is interesting and easy to understand.
	There are no bugs in the game.
	There are clear objectives in the game.
	Information and commands in the game are clearly announced
Compatibility	The game can be run on a PC / laptop and an Android phone

The last is the evaluation stage, carried out at each of the four stages above which is called formative evaluation, because the goal is for revision needs. The evaluation stage is carried out to ensure the developed product is appropriate or needs revision. Activities at this stage include product revision by the validator, implementation reflection, and revision of educational game RPG. The flow of this research can be seen in Fig 3.

Table 2. The validation criteria

Validation Criteria	Validation Level
$85\% < V_{ahli} \leq 100\%$	Very valid, can be used without revision.
$70\% < V_{ahli} \leq 85\%$	Quite valid, can be used but needs a little revision.
$50\% < V_{ahli} \leq 70\%$	Less valid, it is recommended not to use it because it needs a lot of revision
$1\% < V_{ahli} \leq 50\%$	Not valid, may not be used.

The instruments in this study were unstructured interview sheets, validation sheets, practicality questionnaires, and tests of mathematical comprehension abilities. The validators in this study consisted of 3 people, namely 2 lecturers and a junior high school mathematics teacher. The data obtained from the validator are quantitative and qualitative. Quantitative data is used to determine whether the RPG games that have been developed are valid, while qualitative data is in the form of suggestions for improvement so that the resulting product is even better. The validation sheet indicator can be seen in Table 1. The quantitative data on the validation sheet were analyzed to determine the validity level of the RPG games that have been developed. The validation criteria are based on the following Table 2.

Practicality questionnaires are given to students after the implementation of learning using RPG games is carried out. The modified user practice sheet of Hamdunah is shown in Table 3 [18].

Table 3. Practicality

Aspect	Indicators
Convenience	1. Easy game presentation 2. Instructions and requests for easy games understandable 3. Games can be played on a PC / laptop and android.
Language	1. Use clear and easy language to understand. 2. There is no sentence confusing. 3. Scenarios or paths story can be understood.
Game Contens	1. Presentation of the material clearly. 2. Problems in the game can be understood. 3. The pictures that appear clearly. 4. Move to clear map (no confusing). 5. There is interaction in the game with its users
Game Design	1. Attractive appearance. 2. Feel happy learning mathematics with games 3. Increase learning enthusiasm. 4. Learning becomes easy and a lot of fun 5. Games can provide education for users

The criteria for practicality of RPG educational games can be seen in Table 4.

Table 4. Practicality Criteria

Validation Criteria	Validation Level
$80 < P \leq 100$	Very Practical
$60 < P \leq 80$	Practical
$40 < P \leq 60$	Quite Practical
$20 < P \leq 40$	Less Practical
$P \leq 20$	Impractical

The mathematical comprehension ability test consists of 3 questions with indicators: providing examples and not examples of a concept, presenting concepts in various forms of mathematical representations, applying concepts or algorithms in problem solving. All questions contained in the RPG game are guided by indicators of mathematical comprehension ability. Some examples of mathematical comprehension skills can be seen in Table 5.

Table 5. Mathematical comprehension ability

indicators of mathematical comprehension ability	Question
Presenting concepts in various forms of mathematical representations	From the following sets of pairs: a. {(a,2) , (b,3) , (b,4) , (c,5)} b. {(a,2), (b,3),(c,4), (d,5)} Specify: a. Draw arrow diagrams of each set of consecutive pairs b. Which is a function and not a function, along with the reasons.
Provide examples & not examples of a concept	Make an example of a line diagram that shows functions and not functions based on the relationship between friends' names and hobbies, from some of your friends in class.
Apply concepts or algorithms in problem solving	It is known that x is the temperature in degrees Celsius and f (x) is the temperature in degrees of Reamur. The relationship between the two is defined by form $f(x) = \frac{4}{5}x + 32$, Specify: f(x) if x = 30; x if f(x)=100

Before the mathematical comprehension ability test was given during implementation, a test question was conducted on students who had studied the relation and function material. From the test questions, it will be seen the quality per item of questions using validity and reliability tests. The results of the validity test for each question using Pearson product-moment correlation with the SPSS 24 software can be seen in the Table 6.

International Journal of Education and Learning
Vol. 3, No. 2, August 2021, pp. 76-93
ISSN 2684-9240

Table 6. Validation Criteria

Number Test	Validity Index	Level of Validity
1	0.54	Medium
2	0.76	High
3.	0.81	High

Based on the results of the validity test, three questions were considered valid criteria. Furthermore, the results of the reliability test using Cronbach Alpha with SPSS 24 software can be seen in Table 7.

Table 7. Reliability Statistics

Cronbach's Alpha	N of Items
.672	3

Based on Table 7, the cronbach's Alpha value is 0.672 including the test criteria that are reliable or consistent. From the validity and reliability test, then the 3 test questions can be used to measure students' mathematical understanding abilities. The pretest is used to obtain data on the scores obtained by students before being given learning media of educational game design based on android on the material of relations and functions. Posttest is used to obtain score data obtained by students after the implementation of android-based educational games on relation and function material. To see the increase in mathematical understanding ability, the n-gain test is used.

3. Results and Discussion

3.1. Analyze Phase

According to interviews with 3 of 8th-grade students, several problems found. First is monotonous learning methods & media, which make students feel very bored. The second is about the difficulty in distinguishing between relations and functions. Interview with the teacher, the results of the interview found that in general, students still have many problems in learning mathematical relations and the function of learning media. The following is one of the recorded interviews between researchers and students.

R (Researcher) : Do you like math?
S (student) : I do not like it
R : don't like it? Why?
S : dizzy
R : so, if you worked on the relation and function problem, how was that difficult or not?
S : hard
R : How was mathematics learning during a pandemic?
S : Usually uses learning videos uploaded to Google Classroom or Group WhatsApp and then assignments
R : If studying, usually using aids such as media or only using a blackboard?
S : just use a blackboard
R : If studying only using a blackboard, how does it make you bored and bored or just ordinary?
S : yeah .. Sometimes it's bored, sometimes not
R : If later when learning to use media in the form of games in which there is a lesson or not?
S : want
R : Do you think it makes you enthusiastic about learning if you learn while playing games?
S : yes, absolutely spirit

Apart from students, researchers also conducted interviews with VIII-grade mathematics teachers. The following are the results of the interview between the researcher and the teacher.

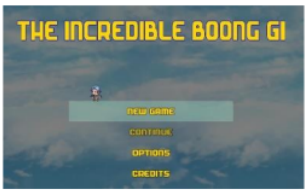
R : What do you think about the use of technology in learning mathematics?
T : I think technology really needs variety for children not bored with monotonous learning.
R : Then how is the use of inner technology of learning in this school, have

there been any applied?
T : For the time being only the use of technology such as video interactive and images via the projector are used only.
R : What do you think about using the game on smartphone as a learning medium for students?
T : I think it is very good and interesting, learning isn't boring. With this game, children also feel challenged and enthusiastic in learning

From the results of interviews with students, they stated that mathematics is a difficult subject. Students have difficulty working on the material relations and functions given by the researcher. Furthermore, based on the results of interviews with teachers, information was obtained that the use of technology will increase the enthusiasm of students in learning mathematics. During the pandemic, the teacher provided learning videos which were uploaded via google classroom. When listening to the material on the learning video, students often speed up the video, so that when asked and answered through google meet students are still confused and have difficulty understanding the material. This has an impact on the value of learning mathematics that has not been completed individually. Therefore, the application of RPG educational games in learning mathematics is urgent. Each material and question in the educational RPG game refer to the core competencies and competency standards in the 2013 curriculum. The questions given focus on students' mathematical understanding abilities.

3.2. Design Phase

Educational games must have a strong fantasy factor so that students feel carried away in the game [32]. This fantasy factor appears in the form of an abstract storyline that contains content or learning material [17]. In addition to the storyline, the RPG game also includes characters, characters, and environments with a specific plot. Indirectly, students are involved in learning through educational games [33].



4a

4b

4c

4d

Fig. 4. ADDIE model, school gate map, school map (bong gi and galuh enter together), and boong gi and galuh are in the school lobby

This game tells the story of a boy named Boong Gi who goes to school. There he met his best friend named Galuh. They go to every class they have together. In this game, three classes must be joined. There are the relations class, function class, and Exam class. Boong Gi must be able to answer all the exam questions correctly to complete this game.

1) Map Creation

Making a Map on the main menu using the Galv in Plugin can be seen as the Fig 4a. In Fig 4a is the main menu display of the game where there are several menu options such as New Game, Continue, Options, and Credits. How to operate it, click on the menu you want.

International Journal of Education and Learning
Vol. 3, No. 2, August 2021, pp. 76-93
ISSN 2684-9240

2) Scenario

It is told by a child in the morning named Boong-Gi as the main character leaving for school. In Fig 4b, Boong-Gi, reaches the school gate. There is a picket teacher to meet. After that there was a friend named Galuh who was waiting and had to meet Boong Gi to enter the class together. This can be seen in Fig 4c. After they enter the school door, then they are in the school lobby. In the school lobby, it appears that there are 3 classes to be followed, namely relations class, function class and exam class. The relation class and function class are on the ground floor, and the exercise class is on the 2nd floor. It looks like in the Fig 4d.

The first class Boong Gi must take is the relationship class. In this class Boong Gi will be taught about relationships with some examples and practice questions. The location of the relations class is on the first floor to the right of the stairs. The relation class design, as in Fig 5. After completing the challenges in the relations class, Boong-gi and Galuh exit the Relationship class, the exit is in the back-right corner of the class. After exiting Boong Gi and Galuh enter the Function class which is to the left of the ground floor stairs. In the function class Boong Gi and Galuh will learn the function material along with examples and practice questions. The design of the function class is shown in Fig 6.

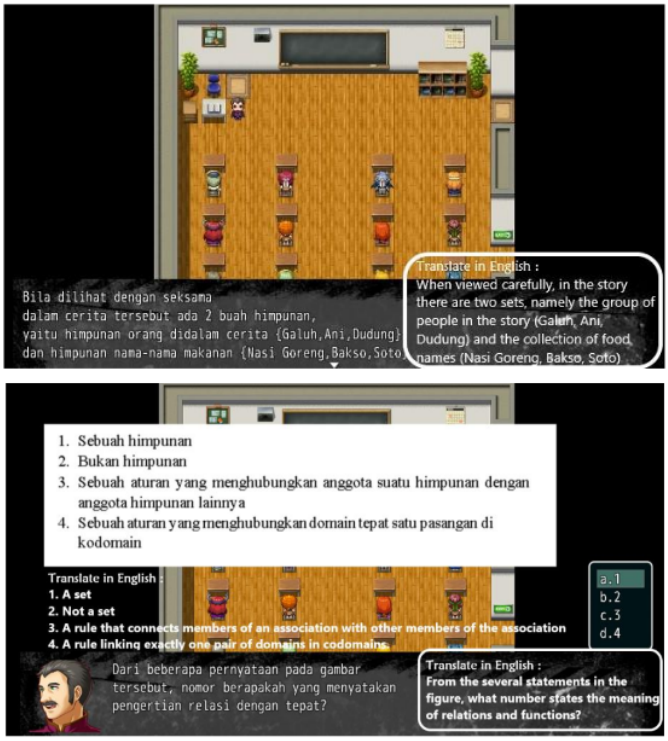


Fig. 5. The Relation Class

After the function class, the last class is the exam class where each student including Boong Gi will enter alone and answer all the exam questions given. The exam class design can be seen as Fig 7.

3) Character Creation

The main character (Boong-Gi) used in this game is made by the author using the character generator from RPG maker, which can be seen in Fig 8. As for other characters using characters that already exist in the RPG maker software. RPG Maker 2003 is the third in the series of programs for the development of role-playing games, developed by Kadokawa Games. It features a database of pre-made backgrounds, music, animations, weapons, and characters.

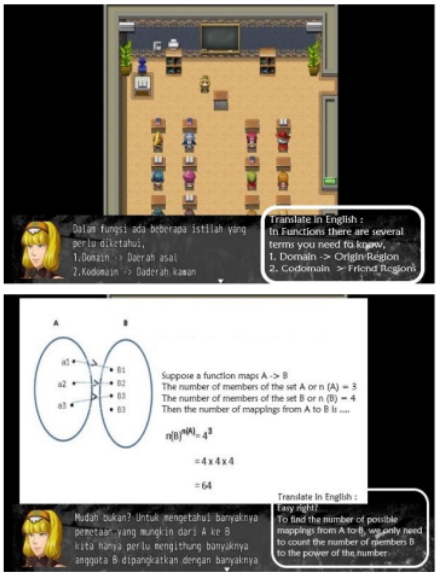


Fig. 6. Function Class

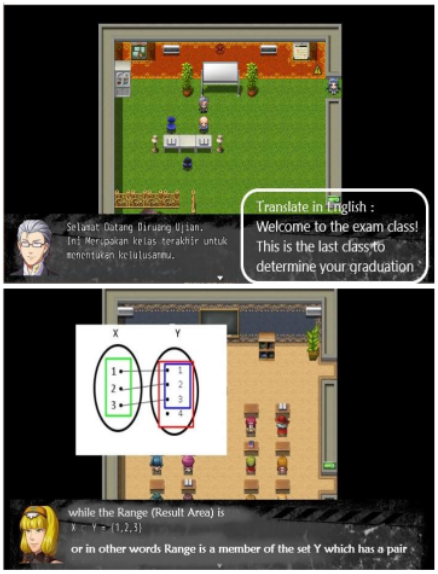


Fig. 7. Exam Class

Fig. 8. Character Making

3.3. Development Phase

This stage will explain how to deploy the game and display the results of validation and practicality

1) Deployment

After designing in the previous stage is complete, the next step is to deploy the game. To deploy the game, go to file > menu > Development (as in Fig 9), then select the android platform and click Ok. This will be saved as a folder called www. (storage location must be remembered). The second stage is to make it into the apk format. The material prepared is Adroid Studio software (Fig 10a) and data AltimitSystems-mv-android-client-6b33d6f to make it an apk game. Next, run the Android Studio software on the PC, then click on open an existing project and select it> AltimitSystems-mv-android-client-6b33d6f as in the following Fig 10b. After the project is opened, click on the application folder as shown in Fig 10c. Then copy the www game data folder that has been deployed on the first step is to the assets folder, as seen in Fig 10d. After that, to make the application enter the Build menu then select Build APK as seen in Fig 10e. Wait a few moments to finish and click locate the app in the event log as shown in Fig 10f to open the apk folder that you have created.

Vol. 3, No. 2, August 2021, pp. 76-93

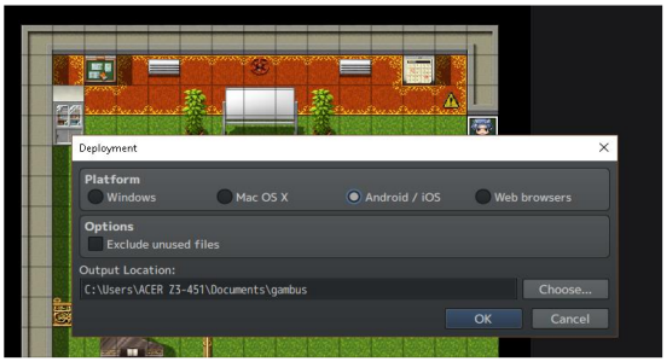
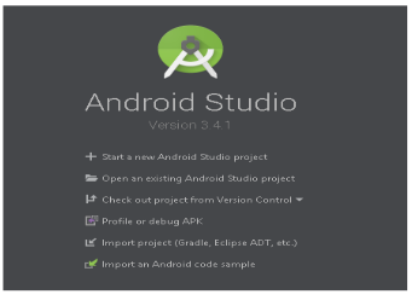
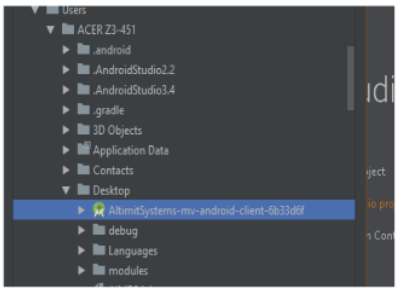


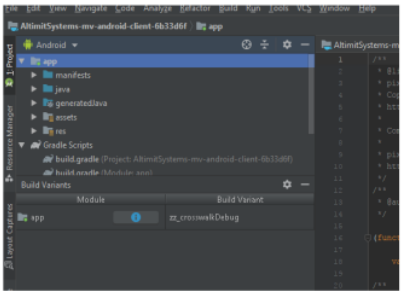
Fig. 9. Deployment Phase



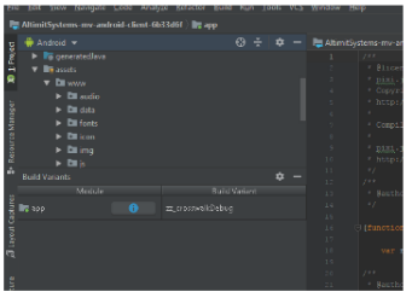
10a



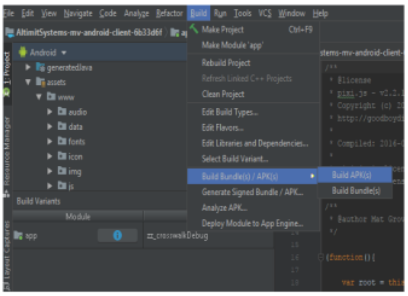
10b



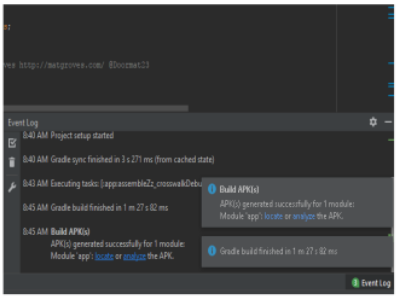
10c



10d



10e



10f

Fig. 10. How to deploy the game and display the results of validation and practicality

2) Media Validation Results

Media validation for three validators, including validator as a media expert, and validator as a material expert. The following are the results of media validation shown in Table 8.

Table 8. The results of media validation

Validator	Validator Criteria
1	97.36%
2	96.05%
3	97.36%

Information,

Validator 1 : Media Expert

Validator 2 & 3 : Materials Expert

The results of the validation of 3 validators on all criteria from each aspect, especially relevance, systematic presentation, design, and compatibility, get a maximum score of four. As for the aspects of the accuracy of learning with the demands of student-centered learning for the criteria of encouraging curiosity, students only get a score of 3. Nevertheless, the game is declared valid and can be used by students in learning, especially for the ability to understand mathematics in material relations and functions. These results are in line with the educational game developed by Risnawati et al. as instructional media to facilitate students in mathematical problem abilities that obtain validation results of 79.2 with valid criteria and a few revisions [34].

Practicallity Results

This study also conducted the user practicality. The subjects consist of nine students. They are three students with high ability, three students with moderate ability, and three students with low ability. The result of user practicality shown in Table 9.

Table 9. Result of Practicality

Capability Level	Evaluator	Percentage	Average Capability Level (%)
High	S-1	98.4%	92.6%
	S-2	93.7%	
	S-3	85.9%	
Moderate	S-4	93.7%	85.3%
	S-5	90.6%	
	S-6	71.8%	
Low	S-7	82.8%	83.3%
	S-8	73.4%	
	S-9	93.7%	

From practicality test results by nine students, the game was declared practical and got an average score of a maximum score of 4 in each assessment on all aspects that were appropriate language, and satisfaction. Only for the map transition criteria in the aspect of game content only get an average value of 2.89 out of a maximum score of 4 or equal to 72%, where students receive little difficulty with transitions each map even though it has given clear instructions. This shows that learning must begin and be guided by the teacher in the learning process. This is in line with Yong et al., that teachers continue to act as facilitators who are open to changing times so that they can create and use Android-based educational games as a complement to learning [35]. From the user practicality test, the rater does not provide suggestions or input on game media that are improvements in the game. The rater only gave a response about the game that the game presented was interesting and provided deeper motivation for learning mathematics. After the practicality test, it was continued at the implementation stage of the RPG educational game.

3.4. Implementation Phase

The implementation stage of the RPG educational game was conducted in two face-to-face meetings involving 9 junior high school students in Lemah Abang, Cirebon Regency. The student activities when using RPG games can be seen in Fig 11.

Fig. 11. Implementation Phase

At the first meeting, a pre-test was carried out and continued with teaching and learning activities using RPG games. At the second meeting the students did the post test. The results of students' mathematical understanding ability tests can be seen in the Table 10.

Table 10. Result of the Mathematical Understanding Ability

Students	Pre-Test	Post Test	Gain-Test	Criteria
S-1	57	76	0.44	Moderate
S-2	61	85	0.62	Moderate
S-3	70	79	0.30	Moderate
S-4	55	67	0.27	Poor
S-5	45	73	0.51	Moderate
S-6	40	79	0.65	Moderate
S-7	39	73	0.56	Moderate
S-8	34	77	0.65	Moderate
S-9	24	79	0.72	High

From the results of the gain test in Table 10 the overall average score of 9 students gets a normalized gain value of 0.52 and is included in the moderate interpretation. This means that there is an increase in students' understanding ability after using the incredible educational game "the Incredible Boong Gi" on the material of relations and functions based on the pretest and posttest scores. This is because with the educational game media students are excited to learn and read the material displayed in the game.

3.5. Evaluation Phase

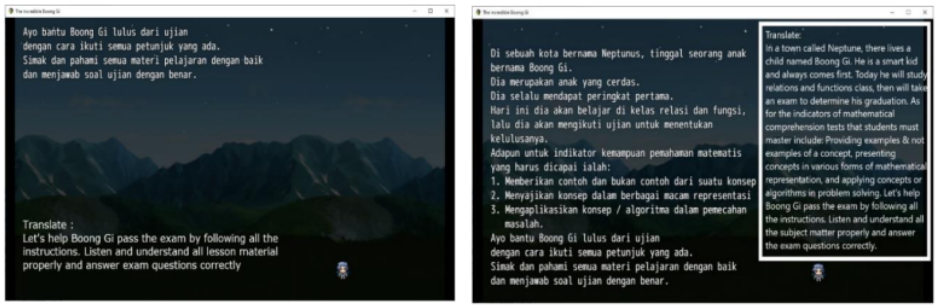
The validator provides suggestions or input on the educational game "The Incredible Boong Gi" as an evaluation material to perfect the game design that has been made. The following are suggestions given by the validator and evaluation results as shown in Table 11. The results of an example of the educational RPG game "The Incredible Bong Gi", before and after the revision can be seen in Table 12. The results of the validation study of the educational game "The Incredible Boong Gi" for the ability of mathematical understanding of the material relations and functions performed by 3 validators obtained an average percentage of 96.90%. Thus, the game "The Incredible Boong Gi" that researchers made for this classified into very valid criteria. This is evidenced from the results of the validation of each aspect of the indicator.

Table 11. Validator Suggestions and Evaluation Results

Validator	Advice	Revised
1	1. Re-check writing and punctuation 2. Add timers to the evaluation questions in the evaluation exam class 3. Instructions before working on evaluation questions. 4. At the beginning of the game include indicators of competency achievement and indicators of mathematical understanding abilitys	1. Writing has been checked and improved. 2. Instructions and timers have been given on the evaluation questions in the Exam class 3. Already included indicators of competency achievement and indicators of mathematical understanding ability
2	Correct some words	Already repaired
3	Enlarge the image in the game	The image has been enlarged

The relevance aspect is one of the 5 existing aspects, which gets a 100% percentage score from each validator. The relevance aspect itself consists of several criteria such as: material that is relevant to the competencies that must be mastered by students; tasks relevant to competencies that must be mastered; as well as exercises and questions in the game relevant to the material presented and relevant to the mathematical understanding ability that must be mastered by students, this shows that the material, assignments, questions, and exercises are very valid and in accordance with the competence and comprehension that must be possessed. The systematic aspect of the presentation is the next aspect that gets a 100% validity value. This aspect consists of 3 criteria, namely: (1) The flow of material in the game follows the flow of thought from simple to complex; (2) The material presented coherently, (3) The content of learning material is easy to understand; (4) Use of language that is clear and easy to understand. This shows that the game serving systematics are very good although there is a suggestion from the validator to double-check the writing and punctuation, but the language in the game is clear and can be understood.

Table 12. Validator Suggestions and Evaluation Results



Before Revision After Revison

Nurhayati et al. stated that interesting media can encourage students' interest to pay more attention [36]. In line with the game "The Incredible Boong Gi" is designed to be a learning medium that is quite interesting. This is evidenced by the results of validation on the aspect of the suitability of the presentation with the demands of student-centered learning with two criteria, namely encouraging curiosity of students and fostering student interaction with games that are presented with a score of 87.5% from 3 validators. Next is the design aspect of the game that has an average score of 97.2%. That is because the game "The Incredible Boong Gi" conforms to the validity standard of game media design in which there are 8 criteria as follows: (1) The appearance of each map is interesting; (2) Movement between folders is clear (not confusing); (3) Prominent characters and characters in the game; (4) The text in the game is clear and legible; (5) The images and audio in the game are clear; (6) Plots or scenarios in the game are interesting and easy to understand; (7) There are no bugs in the game; (8) There are clear objectives in the game; (9) Information and instructions in the game are clearly announced. The results of validation on aspects of design with good visuals will greatly affect the learning media users, namely students.

The last aspect is compatibility aspect which gets an average score of 91.66% where this compatibility has one criterion that the game can be run on a Windows-based PC & Android-based Smartphone, with the other meaning that this game media can be played well wherever and whenever. But for android users it is recommended for smartphones with 2GB RAM specifications and have 1 GB of storage left so that the game can run smoothly. Based on the results of a good percentage score from all aspects that existed by 3 validators, it was found that the media game "The Incredible Boong Gi is very valid, with a clear story line, interesting storyline so that it makes students interested and is expected to be able to increase their mathematical understanding abilities. in the matter of relations and functions. Educational games that have been developed have clear sound / back sounds and do not interfere with student concentration in learning. Byun and Loh stated that among the many game elements, sound is the most important element that can stimulate the user's audio perception. Sound also has a significant influence on student involvement in playing educational games [37].

After conducting the validation test, the game "The Incredible Boong Gi" goes through the user practicality phase. This practicality test was conducted by 9 students consisting of 3 high-capacity students, 3 percent of medium-ability students and 3 participants of low-ability students. The results of the overall each level of user ability, obtained an average score of 87.4%. In other words, that the game "The Incredible Boong Gi" made by researchers is very practical. This user practicality test includes 4 aspects namely ease, appearance, game content, and satisfaction. This is in line with Chen and Ren who stated that several reasons digital educational games are applied in learning including: games combine entertainment and education so that learning is relatively interesting, math problems are packaged in the form of storylines so students can complete tasks without focusing only on mathematical formulas and equations, games provide challenges and games that lead to student satisfaction in playing them [28].

Based on these 4 aspects the game "The Incredible Boong Gi" was declared very practical. This was reinforced by several direct (unstructured) interviews with users, students, that after playing an educational game they felt happy because the storyline and appearance were interesting, the subject matter and exercises were easy to understand. Some students were confused about moving folders, even though there were clear instructions and directions. This shows that students must still be guided by the teacher during learning. This is in line with Yong et al. that teachers continue to act as facilitators who are open to changing times so that they can create and use Android-based educational games as a complement to learning [35]. With game-based learning, there is a shift in the epistemological paradigm from an objectivist perspective to a constructivist perspective [38]. With game-based learning, there is a shift in the epistemological paradigm from an objectivist perspective to a constructivist perspective (Dickey). The game "The Incredible Boong Gi" that has been developed is stated to be valid, practical and has the potential effect of increasing students' mathematical understanding skills in general. This is evident from the results of implementation in small groups, RPG educational games can improve mathematical comprehension skills with moderate criteria. One student from the low group got a high increase after learning relation material and functions using RPG games. The implication of this game in learning is that it is hoped that this game can become a medium used in solving problems in mathematical understanding of relations and functions. The limitation of this study is that it has not been widely implemented. Therefore, in the next study, the effectiveness of RPG games will be examined on the ability of mathematical understanding using quantitative methods and describe student attitudes that are formed after game-based learning.

4. Conclusion

Educational RPG game "The Incredible Boog Gi" based on the ability of mathematical understanding of the material relations and functions developed according to student needs and guided by the 2013 curriculum. This game not only entertains students but has an educational element. The storyline of "Boong Gi" is an adventure story genre where on each story map there is material that must be mastered and questions that must be answered. Based on the results of the expert validators and the media, this game is valid to use. Furthermore, based on the results of user practicality orders, the RPG game "The Incredible Boong Gi" is practical. In the implementation stage, a small group of educational RPG games can improve mathematical comprehension skills with moderate criteria. Hopefully, RPG educational games are also effective in improving mathematical understanding skills in a wider group of students. Therefore, quantitative research is needed to continue this research for users who want to use math educational games "The Incredible Boong Gi" is recommended to use a smartphone with a minimum android version 6.0 Marshmallow and have RAM at least 2GB, and a minimum of 1GB Free Space Memory.

Acknowledgment

The authors would like to thank collagues from SMPN 2 Lemah Abang Kabupaten Cirebon. Also thank to research institutions of Universitas Swadaya Gunung Jati Cirebon and Universitas PGRI Yogyakarta.

Declarations

Author contribution : SS : Writing original draft preparation, editing and visualization. SS : Writing story board for game, writing, and reviewing. LS: Conceptualization and methodology. DF: Making game RPG

Funding statement : This research was funded by Universitas Swadaya Gunung Jati, No: SKEP/356/UNIV/XII/2019

Conflict of interest : The authors declare no conflict of interest.

Additional information : No additional information is available for this paper.

References

[1] M. R. Ramdhani, B. Usodo, and S. Subanti, "Student's mathematical understanding ability based on self-efficacy," in *Journal of Physics: Conference Series*, 2017, vol. 909, no. 1, p. 12065, doi: 10.1088/1742-6596/909/1/012065.

[2] A. Minarni, E. E. Napitupulu, and R. Husein, "Mathematical understanding and representation ability of public junior high school in North Sumatra," *J. Math. Educ.*, vol. 7, no. 1, pp. 43–56, 2016, doi: 10.22342/jme.7.1.2816.43-56, doi: 10.22342/jme.7.1.2816.43-56.

[3] E. E. Rohaeti and M. Bernard, "the Students' Mathematical Understanding Ability Through Scientific-Assisted Approach of Geogebra Software," *Infin. J.*, vol. 7, no. 2, p. 165, 2018, doi: 10.22460/infinity.v7i2.p165-172, doi: 10.22460/infinity.v7i2.p165-172.

[4] H. Hendriana, "Teachers' hard and soft skills in innovative teaching of mathematics," *World Trans. Eng. Technol. Educ.*, vol. 15, no. 2, pp. 145–150, 2017, available at: Google Scholar.

[5] I. Nuryasintia and L. A. Wibowo, "Learning Activeness through Learning Media and Class Management," vol. 65, no. Icebef 2018, pp. 145–148, 2019, doi: 10.2991/icebef-18.2019.35, doi: 10.2991/icebef-18.2019.35.

[6] Setiyani, F. Ferdianto, R. Meidasari, and L. Sagita, "Designing educational game android to improve mathematical understanding ability on fraction," *J. Phys. Conf. Ser.*, vol. 1188, no. 1, 2019, doi: 10.1088/1742-6596/1188/1/012067.

[7] R. Rahaju and S. R. Hartono, "Pembelajaran Matematika Berbasis Permainan Monopoli Indonesia," *JIPMat*, vol. 2, no. 2, 2017, doi: 10.26877/jipmat.v2i2.1977, 10.26877/jipmat.v2i2.1977.

[8] C. Puspitasari, "A New Tool To Facilitate Learning Reading For Early Childhood," *Malaysian Online J. Educ. Technol.*, vol. 5, no. 3, pp. 1–15, 2017, available at: Google Scholar.

[9] N. D. Rahmawati, A. Buchori, and B. Bhihikmah, "Pengembangan Strategi Permainan Tradisional Sunda Manda Pada Pembelajaran Matematika Di Smp," *JIPMat*, vol. 1, no. 2, 2017, doi: 10.26877/jipmat.v1i2.1243, doi: 10.26877/jipmat.v1i2.1243.

[10] L. Ariyanto, N. D. Rahmawati, and A. Haris, "Pengembangan Mobile Learning Game Berbasis Pendekatan Kontekstual Terhadap Pemahaman Konsep Matematis Siswa," *JIPMat*, vol. 5, no. 1, pp. 36–48, 2020, doi: 10.26877/jipmat.v5i1.5478.

[11] A. Suprianto, F. Ahmadi, and T. Suminar, "The Development of Mathematics Mobile Learning Media to Improve Students' Autonomous and Learning Outcomes," *J. Prim. Educ.*, vol. 8, no. 1, pp. 84–91, 2019, available at: Google Scholar.

[12] F. Martin and J. Ertzberger, "Here and now mobile learning: An experimental study on the use of mobile technology," *Comput. Educ.*, vol. 68, pp. 76–85, 2013, doi: 10.1016/j.compedu.2013.04.021.

[13] M. I. I. Haque and D. A. Zuliestiana, "Analisis Positioning Channel Media Review Smartphone Berdasarkan Persepsi Penonton Youtube Di Indonesia Dengan Menggunakan Metode Perceptual Mapping," eProceedings Manag., vol. 5, no. 2, 2018, available at: Google Scholar.

[14] J. Bartley *et al*., "World of workout: A contextual mobile RPG to encourage long term fitness," *Heal. 2013 - Proc. 2nd ACM SIGSPATIAL Int. Work. Use GIS Public Heal. Conjunction with 21st ACM SIGSPATIAL Int. Conf. Adv. Geogr. Inf. Syst.*, pp. 60–67, 2013, doi: 10.1145/2535708.2535718.

[15] S. Amami Pramuditya, M. S. Noto, and D. Syaefullah, "Game Edukasi Rpg Matematika," *Eduma Math. Educ. Learn. Teach.*, vol. 6, no. 1, p. 77, 2017, doi: 10.24235/eduma.v6i1.1701.

[16] D. Ong, C. Y. Yeng, C. W. Hong, and K. T. Young, "Motivation of Learning : an Assessment of the Practicality and Effectiveness of Gamification Within a Tertiary Education System in Malaysia," *World Acad. Res. Educ. Sch. Business, Soc. Sci. Humanit. Educ. (In Assoc. with Acad. World Financ. Banking, Manag. IT) Conf. Proc.*, vol. 1, no. 1, pp. 131–146, 2013, available at: Google Scholar.

[17] Y. R. Shi and J. L. Shih, "Game Factors and Game-Based Learning Design Model," *Int. J. Comput. Games Technol.*, vol. 2015, 2015, doi: 10.1155/2015/549684.

[18] G. H. Lee, A. Z. Talib, W. M. N. W. Zainon, and C. K. Lim, "Learning history using role-playing game (RPG) on mobile platform," *Lect. Notes Electr. Eng.*, vol. 279 LNEE, pp. 729–734, 2014, doi: 10.1007/978-3-642-41674-3_104.

[19] B. S. Ginting and F. Ramadhan, "PERANCANGAN GAME BECOME A KING BERBASIS Budi Serasi Ginting , 2 Fajar Ramadhan," *Manaj. Inform. Komputerisasi Akunt.*, vol. 2, no. 1, pp. 12–21, 2018, available at: Google Scholar.

[20] M. E. Joorabchi and M. S. El-Nasr, "Measuring the impact of knowledge gained from playing FPS and RPG games on gameplay performance," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 6972 LNCS, pp. 300–306, 2011, doi: 10.1007/978-3-642-24500-8_33.

[21] F. Bellotti *et al*., "Designing serious games for education: From pedagogical principles to game mechanisms," *Proc. Eur. Conf. Games-based Learn.*, vol. 2011-Janua, pp. 26–34, 2011, available at: Google Scholar.

[22] D. B. Agusdinata and H. Lukosch, "Supporting Interventions to Reduce Household Greenhouse Gas Emissions: A Transdisciplinary Role-Playing Game Development," *Simul. Gaming*, vol. 50, no. 3, pp. 359–376, 2019, doi: 10.1177/1046878119848135.

[23] I. M. Tegeh and I. M. Kirna, "Pengembangan Bahan Ajar Metode Penelitian Pendidikan dengan ADDIE Model," *J. Pendidik.*, vol. 11, no. 1, p. 16, 2013, available at: Google Scholar.

[24] S. A. Pramuditya, M. S. Noto, and R. N. Azhar, "Mathematics Media Instruction-Based Android for X-Grade Senior High School," *J. Educ. Expert.*, vol. 1, no. 1, p. 1, 2018, doi: 10.30740/jee.v1i1p1-10.

[25] C.-M. Hung, I. Huang, and G.-J. Hwang, "Effects of digital game-based learning on students' self-efficacy, motivation, anxiety, and achievements in learning mathematics," *J. Comput. Educ.*, vol. 1, no. 2–3, pp. 151–166, 2014, doi: 10.1007/s40692-014-0008-8.

[26] M. P. Chen, Y. T. Wong, and L. C. Wang, "Effects of type of exploratory strategy and prior knowledge on middle school students' learning of chemical formulas from a 3D role-playing game," *Educ. Technol. Res. Dev.*, vol. 62, no. 2, pp. 163–185, 2014, doi: 10.1007/s11423-013-9324-3.

[27] A. Kurniati, Nadia, F. Tanzil, and F. Purnomo, "Game Development 'tales of Mamochi' with Role Playing Game Concept Based on Android," *Procedia Comput. Sci.*, vol. 59, no. Iccsci, pp. 392–399, 2015, doi: 10.1016/j.procs.2015.07.549.

[28] M. P. Chen and H. Y. Ren, "Designing a RPG game for learning of mathematic concepts," *Proc. - 2nd IIAI Int. Conf. Adv. Appl. Informatics, IIAI-AAI 2013*, pp. 217–220, 2013, doi: 10.1109/IIAI-AAI.2013.51.

[29] S. A. Pramuditya, M. S. Noto, and D. Syaefullah, "The educational game design on relation and functionmaterials," *J. Phys. Conf. Ser.*, vol. 1013, no. 1, 2018, doi: 10.1088/1742-6596/1013/1/012138.

[30] A. A. Rahman and A. Angraeni, "Empowering learners with role-playing game for vocabulary mastery," *Int. J. Learn. Teach. Educ. Res.*, vol. 19, no. 1, pp. 60–73, 2020, doi: 10.26803/ijlter.19.1.4.

[31] Q. Li, C. Lemieux, E. Vandermeiden, and S. Nathoo, "Are you ready to teach secondary mathematics in the 21st century? A study of preservice teachers' digital game design experience," *J. Res. Technol. Educ.*, vol. 45, no. 4, pp. 309–337, 2013, doi: 10.1080/15391523.2013.10782608.

[32] H. W. H. Din, "Play to learn: Exploring online educational games in museums," *ACM SIGGRAPH 2006 Educ. Program, SIGGRAPH '06*, 2006, doi: 10.1145/1179295.1179309.

[33] Z. Guo, "Based on the RMXP RPG game design and implementation," *Adv. Mater. Res.*, vol. 1044–1045, pp. 1102–1105, 2014, doi: 10.4028/www.scientific.net/AMR.1044-1045.1102.

[34] Risnawati, Z. Amir, and D. Wahyuningsih, "The Development of Educational Game as Instructional Media to Facilitate Students' Capabilities in Mathematical Problem Solving," *J. Phys. Conf. Ser.*, vol. 1028, no. 1, 2018, doi: 10.1088/1742-6596/1028/1/012130.

[35] S. T. Yong, P. Gates, and I. Harrison, "Digital games and learning mathematics: Student, teacher and parent perspectives," *Int. J. Serious Games*, vol. 3, no. 4, 2016, doi: 10.17083/ijsg.v3i4.112.

[36] P. Media *et al*., "Pengembangan Media Permainan Kartu Uno Untuk Meningkatkan Pemahaman Konsep Dan Karakter Siswa Kelas Viii Tema Optik," *Unnes Sci. Educ. J.*, vol. 4, no. 1, pp. 711–719, 2015, doi: 10.15294/usej.v4i1.4974, available at: Google Scholar.

[37] J. Byun and C. S. Loh, "Audial engagement: Effects of game sound on learner engagement in digital game-based learning environments," *Comput. Human Behav.*, vol. 46, pp. 129–138, 2015, doi: 10.1016/j.chb.2014.12.052.

[38] M. D. Dickey, "World of Warcraft and the impact of game culture and play in an undergraduate game design course," *Comput. Educ.*, vol. 56, no. 1, pp. 200–209, 2011, doi: 10.1016/j.compedu.2010.08.005.

Educational_game_RPG_for_mathematical_understanding_ab...

ORIGINALITY REPORT

14%	8%	11%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Setiyani, F Ferdianto, R Meidasari, L Sagita. "Designing educational game android to improve mathematical understanding ability on fraction", Journal of Physics: Conference Series, 2019 Publication	5%
2	pubs2.ascee.org Internet Source	4%
3	F Ferdianto, Setiyani, D Nurulfatwa. "3D page flip professional: Enhance of representation mathematical ability on linear equation in one variable", Journal of Physics: Conference Series, 2019 Publication	1%
4	repository.uhamka.ac.id Internet Source	1%
5	icomse.fmipa.um.ac.id Internet Source	1%
6	icracos.lppm.unesa.ac.id Internet Source	1%

7	Wen Heng Fu, Satrianawati Satrianawati. "The episteme of happiness as ontological vertical in modern education: The maslow answer", International Journal of Education and Learning, 2020 Publication	1 %
8	R A Pratama, D Larasati, H Khotimah. "TORIQ: Android-based mobile learning for vector lessons", Journal of Physics: Conference Series, 2020 Publication	1 %
9	Suherman, Nanda Ayu Rahmadani, Tibor Vidákovich, Mujib et al. "SQ3R method assisted by ethnomathematics-oriented student worksheet: The impact of mathematical concepts understanding", Journal of Physics: Conference Series, 2021 Publication	1 %
10	Ruli Astuti, Nur maslikhatun Nisak, Ainun Nadlif, Adea Wulan Hajjatul Zamzania. "Animated video as a Media for Learning Science in Elementary School", Journal of Physics: Conference Series, 2021 Publication	1 %

Exclude quotes	On	Exclude matches	< 1%

Exclude bibliography On